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(54) **Alarm system for agricultural equipment**

(57) The invention relates to agricultural equipment (1) having an alarm system operative in the event of detection of a malfunction to emit an audible alarm signal that is characteristic of the malfunction and intuitively associated by the vehicle operator with the malfunction.

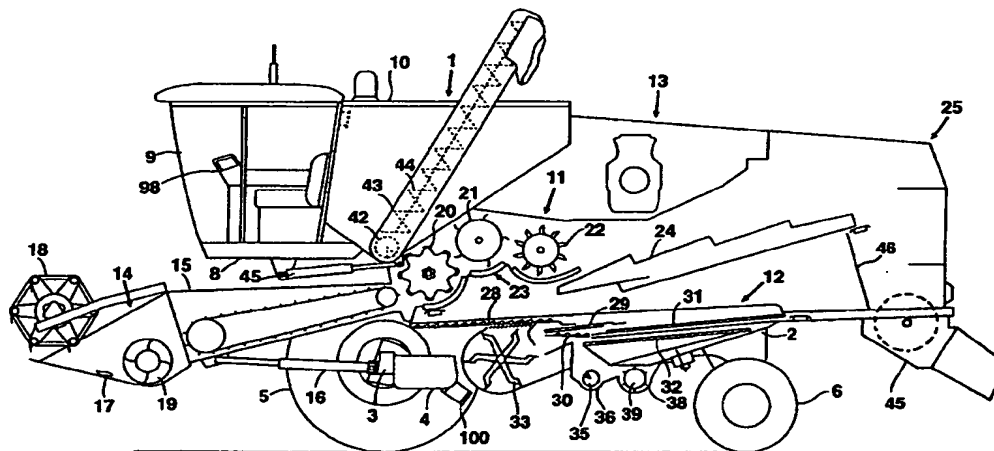


FIG. 1

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floats slightly above ground level. The sickle bar comprises a set of side-by-side arranged triangular knife sections which are reciprocated in a transverse direction. The cutting edges of the knives cooperate with stationary knife fingers to cut the crop stems loose from their roots as the machine travels over the field. Meanwhile a transverse header reel is rotated to guide the cut stems to the rear of the header and within reach of a transverse auger 19. This auger has two opposite flight sections which convey the cut crop to the center of the header, which registers with the mouth of the straw elevator housing. At this stage the crop material comprises the stems and the ears with the grain kernels.

[0017] The straw elevator 15 comprises a set of four chains which at regular intervals are interconnected by transverse angled profiles. The profiles grab the material delivered by the auger 19 to the mouth of the elevator housing and convey it upwardly and rearwardly to the threshing mechanism 11. The material is impacted by a threshing drum 20 which co-operates with a concave 23 to loosen the grain kernels from the ears. The concave consists of transverse sections of flat steel through which extend perpendicularly thick steel wires, thus forming a grid retaining the straw, but allowing the kernels to pass through. The threshing action follows mainly from the interaction of the slats of the threshing drum with the edges of the flat steel sections of the concave 23. When the concave is properly adjusted to the path of the drum slats, most of the grain kernels are beaten out of the ears by this first drum 20.

[0018] The material which reaches the rear end of the concave 23 consists of a mixture of straw (the crop stems), ears, kernels and small crop particles (termed chaff). In order to prevent further rotation of the material by and around the threshing drum 20, the material is taken off from the circumference of the drum by the flights of the beater drum 21. A further concave is installed below the drum for allowing loosened grain kernels to fall to the cleaning mechanism 12 below. The beater drum 21 delivers the mixture of crop material rearwardly to a rotary separator 22. This rotor has outwardly extending teeth which tear apart the mixture, thereby braking up the layer of material delivered by the beater drum 21. Also the rotary separator has a concave below, permitting the further deposit of grain on the cleaning mechanism 12.

[0019] The material from the rotary separator is deposited onto the front end of the straw walkers 24. The five or six straw walkers 24 are mounted on crank sections of two transverse axles. These crank sections are phased such that upon rotation of the axles the straw walkers move in circular patterns. Each straw walker moves rearwardly in the upper part of the pattern and downwardly in the lower part. The phasing assures that a forwardly moving straw walker lies between upwardly and rearwardly moving straw walkers. In this manner the long stems in the threshed crop material are moved to the rear of the combine. The straw is engaged by the teeth on the side sections of the straw walkers during their upward and rearward travel. The straw walkers 24 loosen the material such that the kernels can fall from between the straw material. On their upper surface the walkers have grid sections permitting the kernels to drop through. These kernels are received in the trough-like bottom sections of the straw walkers and slide therealong to the front end of the walkers, from where they drop on the cleaning mechanism 12. Meanwhile the straw is moved over the straw walkers to the rear end of the combine underneath the straw hood 25, from where it is allowed to fall onto the field. Alternatively the straw may be guided by a guide plate 46 into a rotary straw chopper 45 which comminutes the straw and ejects its in a wide pattern onto the field.

[0020] The threshing drum 20 and its concave 23 are usually referred to as the threshing mechanism, i.e. the device performing the most vigorous action on the crop material. The rotary separator 22 and the straw walkers 24 constitute the separating mechanism, i.e. the device effecting the separation of the threshed grain kernels from the straw.

[0021] The material which is deposited on the cleaning mechanism not only consists of grain kernels, but also of other small particles of crop material, broken or unbroken ears, short straw and chaff.

[0022] The bulk of the material that comes from the threshing mechanism, is deposited onto a corrugated grain pan 28. This plate is oscillated to convey the material rearwardly while leveling the same. During their rearward movement the kernels have a tendency to migrate below the lighter remainder of the crop material and to concentrate near the bottom of the grain pan 28. An even layer of crop material falls from the grain pan 28 onto a pre-cleaning sieve 29. This is a first adjustable sieve. During its fall from the grain pan to the sieve 29 the material is engaged by an air flow from the fan 33 such that the lighter particles are blown rearwardly. The same fan arrangement provides an air flow through the pre-cleaning sieves 29 and the subsequent sieves 31, 32 for blowing the light material travelling thereover rearwardly and out of the combine 1.

[0023] The material which falls through the pre-cleaning sieve 29 (mostly grain kernels), is received on a small grain pan 30 which guides it to the lower sieve 32. This lower sieve is the grain sieve, which is adjusted to let pass only grain kernels. Above the grain sieve 32, there is a chaffer sieve 31, which receives most of the material delivered by the pre-cleaning sieve 29 and the bottoms of the straw walkers 24. This upper sieve is set to a larger aperture than the grain sieve 32 below. Material falling through a properly adjusted grain sieve 32 will contain nothing more than grain kernels. They fall onto a clean grain chute which guides them forwardly to a transverse auger trough 36. A clean grain auger 35 pushes the grain sideways to a clean grain elevator (not shown) on the right hand side of the combine. At the height of the grain tank 10, the elevator delivers the grain kernels to a bubble-up auger (also not shown) which deposits the grain on top of the grain already delivered into the grain tank.

[0024] As to the material travelling over the chaffer sieve 31, larger crop particles are conveyed out of the combine

(continued)

Condition	Sound
Air filter pressure	Sound of a clogged vacuum cleaner
Grain tank nearly full	Sound of engaged unloading auger
Grain tank full	Sound of grain pouring into a bin or on the roof
Air conditioning too high or too low	Sound of a freezer compressor
Engine at maximum power limit	Sound of a stalling engine
Grain loss level too high	Sound of kernels falling on a plate, the rate increasing with the loss level.

15 **[0031]** In the case of all the faults listed in the table, it is possible to generate sounds that intuitively indicate to the operator the nature of the malfunction. In certain other cases, for example in relation to the shaft speed monitor of the chaff spreader, where there is no sound that is naturally associated with the fault condition, it is possible to generate a strong beep and it is not essential that all the alarm sounds should be naturally associated with the related fault condition.

20 **[0032]** As can be seen from the table, sounds can be mixed. Thus, the sound of a slowing belt can be mixed with the sound of a threshing mechanism 20, 23 to indicate that there is a fault indication from a shaft speed monitor associated with part of the threshing mechanism.

[0033] Using a stereo audio system, it is possible to provide directional information so that where there are duplicated items of equipment on the opposite sides of the vehicle, the direction of the alarm sound can indicate the side of the vehicle on which a malfunction has occurred.

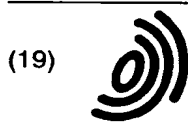
[0034] The amplitude of the alarm signal can if desired be varied to indicate the urgency or severity of the alarm condition and the importance that the operator should attach to the warning.

[0035] The various alarm sounds can be synthesized but most simply they can be recorded from a machine and processed electronically to achieve the desired sound.

30 **[0036]** It will be clear that the invention can be applied to agricultural equipment other than combine harvesters and that the table given above does not contain an exhaustive list of sounds associated with fault conditions occurring in agricultural vehicles.

Claims

- 35
1. Agricultural equipment (1) having an alarm system operative in the event of detection of a malfunction to emit an audible alarm signal, characterized in that said signal is characteristic of the malfunction and intuitively associated by the vehicle operator with the malfunction.
 - 40 2. Agricultural equipment according to claim 1, characterized in that said signal is non-verbal and non-musical.
 3. Agricultural equipment according to claim 1 or 2, characterized in that the audible alarm signal is generated by picking up and relaying the sound generated by the malfunction to the vehicle operator.
 - 45 4. Agricultural equipment according to any of the preceding claims, characterized in that the audible alarm signal is synthesized to be reminiscent of the sound that one would associate with the malfunction.
 5. Agricultural equipment according to any of the preceding claims, characterized in that the audible alarm signal is a mixed signal, part of alarm signal indicating the nature of the malfunction and the other the origin of the sound.
 - 50 6. Agricultural equipment according to any of the preceding claims, characterized in that the alarm signal is generated in stereo and the direction of the sound is indicative of the side of the vehicle on which a malfunction has occurred.
 7. Agricultural equipment according to any of the preceding claims, characterized in that the various alarm signals generated by the alarm system are of different amplitude, the loudness of an alarm sound indicating the urgency or severity of the alarm condition.
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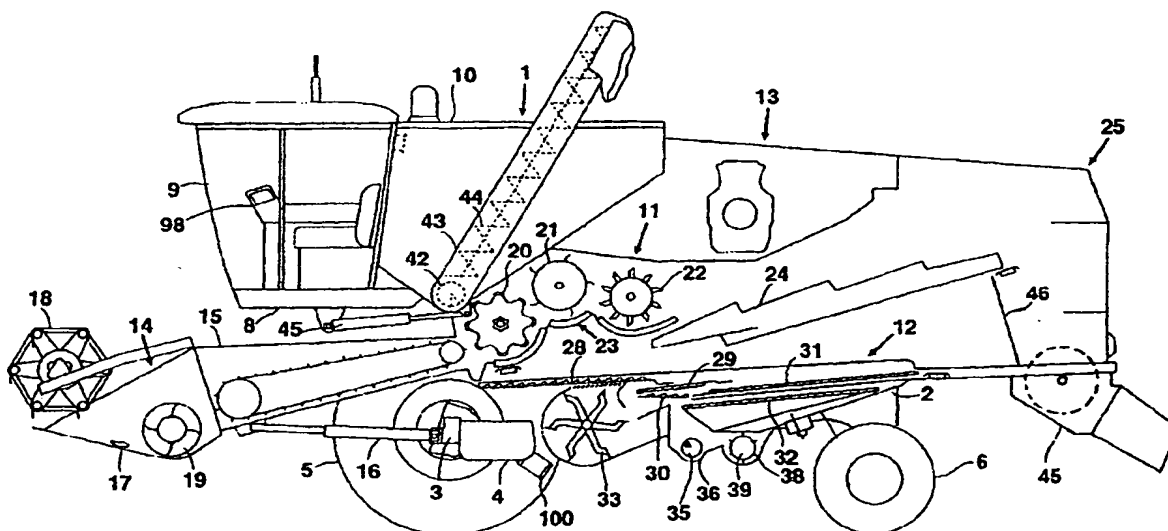


FIG. 1

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 00 20 0821

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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